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(54) METHOD FOR THE PRODUCTION OF A LOW-LOSS OPTICAL WAVEGUIDE

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Abstract

Optical waveguides are produced by collapsing inside-coated glass tubes to form a massive blank, then drawing out. Either a doping substance, particularly germanium oxide, can be added to the core so as to increase the refractive index, or the core can be made of pure SiO_2 , wherein the areas farther from the core can contain, for example, fluorine, for the lowering of the refractive index. By evaporating germanium dioxide during the collapsing, however, the transmission characteristics of the finished optical waveguide are impaired; optical waveguides produced up to now, with a core of pure SiO_2 , exhibit higher losses than theoretically expected. The new method will produce optical waveguides of better quality, with a pure SiO_2 core.

A low-loss optical waveguide with an increased transmission bandwidth and low bending losses, with a pure SiO_2 core, can be simply produced by establishing an oxygen pressure of $p < 10$ mbar in the inner space of the glass tube during the collapsing or during the glass tube drawing-out process.

Production of an optical waveguide.

Claims

1. Method for the production of an optical waveguide--which is made of pure SiO_2 , at least in its inner core area--from a glass tube with a suitable refractive index distribution over the wall thickness, by collapsing this glass tube to form a massive blank and drawing out to a fiber or by direct drawing out of the glass tube to form an optical waveguide, characterized in that an oxygen pressure of $p < 10$ mbar is established in the inner space of the glass tube during the collapsing or glass tube drawing-out process.
2. Method according to Claim 1, characterized in that the desired oxygen pressure is established by a mixture of oxygen with at least one other gas.
3. Method according to Claim 2, characterized in that a noble gas is admixed with the oxygen.
4. Method according to Claim 2, characterized in that nitrogen is admixed with the oxygen.

Description

The invention refers to a method for the production of an optical waveguide--which is made of pure SiO_2 , at least in its inner core area--from a glass tube with a suitable refractive index distribution over the wall thickness, by collapsing this glass tube to form a massive blank and drawing out to form an optical waveguide or by indirect [sic; direct] drawing out of the glass tube to form an optical waveguide.

Important processes for the production of optical waveguides are the methods of coating the tube interior (MCVD, PCVD, PICVD methods). Thin layers of doped quartz glass are deposited on the inside of a quartz tube. The desired radial refractive index course is established by the selection and concentration of the doping agent of the individual layers, wherein the core has a higher refractive index than the jacket.

After the coating, the tube is collapsed in several steps at an elevated temperature to form a rod, which can be drawn out to an optical fiber. However, it is also possible to draw out an optical fiber directly from the described tube, without collapsing the tube to a rod beforehand.

The most frequently used core doping agent is germanium. One disadvantage of this doping agent is the dip in the refractive index in the core center, which arises during collapsing due to the evaporation of said doping agent. This reduces the transmission bandwidth in gradient index fibers.

In particular with monomode fibers, the bending losses are increased by the dip.

Moreover, transmission losses are theoretically increased by the doping, with respect to a pure SiO_2 core.

An optical waveguide with a pure SiO_2 core exhibits a dip and should theoretically have the lowest losses. However, the optical fibers produced up to now, with a pure SiO_2 core, clearly exhibit higher losses than theoretically expected.

To reduce transmission losses, Bachmann et al. proposed (Procee. IODC/ECOC 1985, Venice, pp. 81-85) adding small amounts of germanium to the core. The required lowering of the refractive index of the jacket occurred by doping with fluorine.

This state of the art has various disadvantages because of the germanium doping:

- I. there is, once more, a refractive-index profile disturbance in the core area, which impairs the bending sensitivity of the optical fiber;
- II. the sensitivity with respect to transmission-loss-increasing environmental influences, such as the effect of hydrogen, for example, when using optical fibers in undersea cables, or radiation, is increased;
- III. high production costs because of the expensive germanium and the need for an expensive gas producer.

The goal of the invention is therefore to produce a low-loss optical waveguide with a pure SiO_2 core in a simple manner, in order to avoid the aforementioned disadvantages of the doped optical waveguide.

This goal is attained by the features indicated in the characterizing part of Claim 1.

It was surprising to attain a reduction of the losses with such a low O_2 pressure, since with such a low supply of oxygen, a specialist would have expected a reduction of SiO_2 to SiO and thus an increase in losses.

The procedure can be such that oxygen with an appropriate pressure is present as the only gas in the interior of the glass tube, or that at least one other gas is admixed with the oxygen, in order to establish the oxygen pressure.

An exemplified embodiment of the invention is explained below:

A quartz glass tube is coated on the inside, according to the PICVD method, as it is described in West German Patent No. 3,010,314. First, a coating with the mass flows of the gas components O_2 , SiCl_4 , CCl_2F_2 of 200, 50, and 1.5 mL/min, respectively, is applied as the optical waveguide jacket. A core layer of pure SiO_2 is then precipitated with the mass flows of 200 mL/min of O_2 and 50 mL/min for SiCl_4 . Subsequently, the coated tube is heated to temperatures between 2000°C and 2400°C with a burner, wherein it collapses to form a rod in several steps.

During the collapsing, an oxygen/argon mixture, approximately under standard pressure, is conducted through the tube, wherein the oxygen partial pressure is 1 mbar before the entry of the gas mixture into the tube.

The blank thus produced is then drawn out to an optical fiber, which has the advantageous characteristics described above.